ATLAS Detector Power Supply Workshop

CERN, 12 May 2000

Summary

Reported by: C.Parkman CERN, 15 May 2000

Extract

The aims of the workshop were:

"To identify areas of commonality in basic power supply functionality, tolerance to radiation and magnetic fields, and control and monitoring, which could lead to a co-ordinated R&D programme, procurement and support".

It was attended by more than 30 representatives of the ATLAS sub-detector and CERN support groups as well as other interested parties.

The programme consisted of:

- An introduction giving the background and aims of the workshop and an overview of the ATLAS environment
- A presentation by each of the sub-detectors of their status and requirements,
- A review of relevant radiation and magnetic field tests and the detector control system,
- Discussions on the aims of the workshop.

There are broadly similar requirements in two groups:

- Pixels and SCT
- Liquid Argon, Tiles and Muon

The TRT has the least demanding requirements and may be able to collaborate with either or both groupings.

The workshop concluded that the following actions were desirable:

1. The establishment of a centralised list of basic power supply parameters,
2. The encouragement of further discussions on a common approach to the development and procurement of power supplies and to a coherent programme of testing for radiation and magnetic field effects

Contents

1. Programme

1.1 Introduction

09:00-09:10 Background & aims - Philippe Farthouat

09:10-09:30 ATLAS environment: radiation, magnetic field, cooling - Mike Price

1.2 Sub-detector requirements

09:30-10:00 Pixel Detector - Susanne Kersten

10:00-10:30 Semiconductor Tracker - Jan Stastny

10:30-11:00 Transition Radiation Tracker - Zbyszek Hajduk

11:00-11:15 BREAK

11:15-11:45 Liquid Argon Calorimeter - Helio Takai

11:45-12:15 Tile Calorimeter - Georges Blanchot

12:15-12:45 Muon Spectrometer - Robert Richter

12:45-14:00 BREAK

1.3 Power supply and component tests

14:00-14:30 Experience at Brookhaven - Helio Takai

14:30-14:50 Neutron radiation tests - Bruno Allongue

14:50-15:20 Radiation tolerant techniques - Martin Dentan

15:20-15:30 Power supply control and monitoring - Helfried Burckhart

15:10-15:30 BREAK

1.4 Discussion

Animated by Marzio Nessi

2. Sub-detector requirements

Speakers were asked summarise the following points:

2.1 Requirements

Voltages, currents, number of channels, control and monitoring - parameters and methods.

2.2 Location

On detector or off detector with preferred location, implications on cable dimensions, cost, power losses, regulation and noise performance.

2.3 Responsibility

The institute or institutes, and persons responsible for the power supply production.

2.4 Schedule

Development, prototype, production and installation with cost targets.

2.5 Tests

Outline of tests so far performed.

3. Report

This report is based on the discussion lead by Marzio Nessi, which aimed at uncovering common aims and projects, the speaker's presentations and notes taken during the meeting.

3.1 Parameters

A preliminary table of basic power supply parameters was established, based on the numbers given by the speakers of the day:

System	No. of modules	Power/module (W)	No. of voltages	Special features
Pixels	1000	48	7	Vdet
SCT	4088	9	7	2mV ripple, Vdet
TRT	1500	50	3	
LARG	58 8	3300 200	7 6	
Tiles	32	2200	7	3mV ripple
Muons MDT CSC RPC TGC	 1200 64 550 600	 40 40 60 60	 2 2 2 2	

3.2 Environmental considerations

The environmental conditions and the need for the best possible figures for radiation and residual magnetic field levels as well as minimum heat dissipation into the cavern air were discussed.

The need to incorporate large safety factors may lead to a heavy over-specification of components in terms of radiation resistance and tolerance to magnetic fields. The efficiency of the power supply and power cable cooling was discussed, with some doubts being expressed on the efficiency of cooling power transmission cables.

The use of long cables and consequent need for and "over-supply" factor of up to 2.5 owing to the losses in the cables as well as the consequent need for cable heat removal via the detector cooling return flow was brought up. Some concern was provoked by the Pixels intention not to use remote sense, but to rely on voltage control in the remote power supply based on known cable impedance, owing to lack of space for sense line cabling.

3.3 Bulk power

The possibility and desirability of using remote bulk power with local, on-detector regulation and control including the effect on cable length, grounding, installation space and cost, as well as on the control and monitoring, was discussed.

3.4 Reliability and accessibility

Different approaches to reliability for inaccessible power supplies (e.g. LARG in the fingers) and more accessible positions in UX15 and USA15.

3.5 Monitoring and control

Diverse approaches are being taken to the monitoring and control of power supplies. In general the DCS was intended to be used only to report on power supply status and not for the closed loop control of power supplies. The LMB was proposed as a possible monitoring input to the DCS CANbus, but was seen to be restricted in its application by its limited radiation tolerance. A consistent approach to the connection to the DCS was seen as desirable, in particular the use of high-level software protocols.

3.6 Procurement and support

The different sub-detectors have mixed approaches to power supply procurement ranging for a complete, commercial out-sourcing to total in-house development. Several of the sub-detectors have already made approaches to one or more vendors for prototype equipment; these contacts have had mixed success. It was suggested that co-ordination of these contacts and a sharing of experience could provide savings in time and, very likely, cost.

3.7 Radiation and magnetic field tolerance

Tests of radiation tolerance have been carried out at CERN and Brookhaven. These tests have concerned neutron flux and have been carried out at the French "Prospero" facility and at BNL. Further tests with protons and heavy ions testing for single event upsets and single even gate ruptures are scheduled for this year at BNL, Triumf with other tests possibly at Louvain-la-Neuve or CERI (Orleans, France).

Tests of sensitivity to magnetic fields have been carried out at the component level (e.g. on Vicor converters at BNL and a variety of power supply components at CERN).

Some radiation-provoked problems (e.g. with opto-couplers) have been identified and solutions found. Co-ordinated testing of equipment could allow significant savings in cost and time. It was suggested that small quantities of local ferro-magnetic shielding might provide a sufficient solution for sensitive, non electro-mechanical components. In locations with significant magnetic fields, electric motors as used in cooling fans will almost certainly have to be replaced by pneumatic or hydraulic motors, or avoided altogether.

3.8 High voltage power supplies

High-voltage power supplies did not figure large in the presentations and discussions. The Pixels required a common control over their high and low voltage for reasons of safety.

3.9 Perceived commonality

Owing to their similar detector technology, there appeared to be some commonality between the requirements of the Pixels and the SCT as well as between the Liquid Argon and Tile Calorimeters and the Muon Spectrometer. The TRT have produced a complete requirements document, but are in a position to adopt or adapt an existing solution. Whilst no complete, common solution could be seen immediately, it was believed that there is still room for common approaches to elements of the power supply systems.

4. Conclusions

4.1 List of requirements

The first step to an enhanced co-ordination is to establish an up-to-date list of basic power supply requirements: numbers of channels, voltages and currents and to establish a set of minimum guidelines for control and monitoring.

4.2 Environmental conditions

It is important to establish relevant environmental parameters as precisely and as soon as possible for zones where power supplies could be located on the detector (e.g. between the fingers and on the UX15 shelves). These parameters include the magnetic field, the total ionising dose and hadron fluence. In addition, clear requirements and guidelines for the cooling of cables are urgently required.

4.3 Monitoring and control

A consistent approach to the monitoring and control of power supplies is required in terms of parameters reported and in the use of software protocols.

4.4 Enhanced contacts within ATLAS

The discussion concluded that enhanced contacts between ATLAS sub-detectors on power supply requirements, design, procurement and operation are needed to extract the maximum of commonality and to exploit effectively and economically basic technology such as tests on sensitivity to radiation and magnetic fields.

A view of the power supply developments is required to ensure that prototypes can be correctly productionised and supported during the lifetime of the experiment.

5. Recommendations

It was recommended to:

1. Publish a list of power supply requirements, initially based on the presentations made at the workshop,
2. Take steps to enhance contacts between sub-detectors, on all aspects of power supply design and procurement,
3. Hold another meeting later this year to report on progress made.

C.Parkman was asked to establish the list of parameters and to co-ordinate further discussions and the flow of information.

6. Participants

Name	Affiliation
Allongue, B.	CERN / EP / ESS
Blanchot, G	ATLAS Tile Calorimeter
Brettel, H	ATLAS Muon LARG HEC
Burckhart, H.	ATLAS DCS, CERN EP / OPD
Cwienk, W	ATLAS Muon LARG HEC
Dentan, M.	ATLAS FE Electronics, CERN EP / ATE
Dumont, G.	CERN / EP / ESS
Farthouat, P.	ATLAS FE Electronics, CERN EP / ATE
Fontaine, P.	CERN EP / ESS
Hajduk, Z	ATLAS TRT
Hallgren, B.	ATLAS DCS, CERN EP / ATD
Hasuko, K	ATLAS Muon TGC, University of Tokyo
Hundzinger, J-D	CERN / SL / PO
Jarron, P.	CERN / EP / MIC
Kersten, S.	ATLAS Pixel Detector
Lupu, N.	ATLAS Muon TGC, Technion
Martin, M	CERN / LHC / ACR
Merkel, M	CERN IT / CO
Nessi, M	ATLAS Tile Calorimeter
Olsen, O	CERN / SL / CO
Olszowska, J.	ATLAS TRT, CERN IT / CO
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Price, M.	ATLAS Technical Co-ordination
Rausch, R.	CERN / SL / CO
Richter, R.	ATLAS Muon MDT, Muon Electronics, MPI
Rivetta, C.	CMS
Rodriguez, M	CERN / LHC / ACR
Sasaki, O.	ATLAS Muon TGC, KEK
Stastny, J	ATLAS Semiconductor Tracker
Stefanini, G.	ALICE, EP / AIT
Takai, H.	ATLAS Liquid Argon Calorimeter, Brookhaven
Tarem, S	ATLAS Muon TGC, Technion
Van Sprolant, W	CERN / EP / ESS
Vazeille, F.	ATLAS, Tile Calorimeter

7. Presentations

Introduction

Background & aims - Philippe Farthouat

ATLAS environment: radiation, magnetic field, cooling - Mike Price

Sub-detector requirements

Pixel Detector - Susanne Kersten

Semiconductor Tracker - Jan Stastny

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